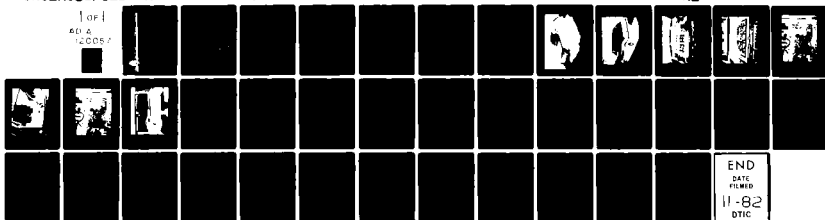


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Report 2358

VERIFICATION TESTS OF THE U.S. ELECTRICAR
CORPORATION ELECTRIC LEOPARD

by
Edward J. Dowgiallo, Jr.
Ivan R. Snellings
and
Robert D. Chapman

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April 1982

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U.S. ARMY MOBILITY EQUIPMENT
RESEARCH AND DEVELOPMENT COMMAND
FORT BELVOIR, VIRGINIA

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Letric Leopard manufactured by U.S. Electricar Corporation was tested at MERADCOM as part of the Department of Energy project to verify conformity to performance standards of electric vehicles. The Leopard is a standard Fiat Strada sedan which has been converted to an electric vehicle. It is powered by 16 6-V batteries through a silicon-controlled rectifier (SCR) Controller to a 23-hp series-wound d.c. motor. It is equipped with a five-speed manual transmission, power-assisted disc brakes in the front and drum brakes in the rear. It is not equipped with regenerative braking.		

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PREFACE

Michael E. Johnson, P.E., of VSE Corporation was responsible for aspects of calibration of the signal conditioning circuits and recording instruments as well as data tabulations.

Aubrey Thomas, Jr. and James A. Queen of the Environmental and Field Division, Product Assurance and Testing Directorate, assisted in vehicle operation and data collection.

The report was prepared to document work sponsored by the United States Government. Neither the United States nor its agent, the United States Army, nor any Federal employees, nor any of their contractors, sub-contractors, or their employees makes any warranty, express or implied, or assumes any legal information, apparatus, product, or process disclosed, or represents that its use would infringe privately-owned rights.

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation. This vehicle was tested to determine its conformity to the Department of Energy, "Performance Standards for Demonstrations." The results reported herein show the nominal capability of the vehicle when it failed to meet the standards. The vehicle may exceed the performance reported herein in actual use. It also may have safety features and amenities not required by the Department of Energy Standards.

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VERIFICATION TESTS OF THE U.S. ELECTRICAR CORPORATION LECTRIC LEOPARD

I. SUMMARY

The Lectric Leopard, manufactured by U.S. Electricar Corporation, was tested during the period 3 August 1981 to 25 September 1981. Part of the verification results are summarized below (complete test results are contained in Section V):

Acceleration: 0-50 km/h (31.1 mi/h) in 9.9 s.

Range: SAE J227a cycle "C" on level (\pm 1-percent grade) terrain yielded 66.2 km (41.2 mi) and 120 cycles.

Forward Speed Capability: Forward speed of 30 km/h (50 mi/h) was maintained for more than 5 min on the level (\pm 1-percent grade) portion of the MERADCOM Test Track.

Gradeability at Speed: At 25 km/h (15.5 mi/h) the vehicle can traverse a 15.5-percent grade based on calculations from acceleration tests.

Gradeability Limit: Calculations based on drawbar-pull test indicate a 35.2-percent forward and a 36.4-percent reverse gradeability for at least 20 s.

II. INTRODUCTION

The Lectric Leopard was operated to determine conformity to the Department of Energy (DOE) "Performance Standards for Demonstrations," published in the Federal Register, Part IV, 12 February 1980 (Appendix A). The results of that testing, as performed by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), as well as other descriptive data concerning the vehicle, are presented in this report.

III. OBJECTIVES

The objectives of the tests were to examine the Lectric Leopard for suitability of those aspects of vehicle and component operating characteristics as outlined by DOE's "Performance Standards for Demonstrations" and the DOE Electric and Hybrid Vehicle Verification Procedures (Appendix B).

IV. TEST VEHICLE DESCRIPTION

The Lectric Leopard is a standard Fiat Strada sedan which has been converted to an electric vehicle (Figures 1 and 2). The vehicle has a wheelbase of 2.19 m (96.4 in.), is 4.08 m (161 in.) long, and is 1.65 m (65 in.) wide. It has a curb weight of 1491 kg (3288 lb) and a gross weight of 1709 kg (3768 lb) and can seat four people, including driver, comfortably. However, it was tested with the weight equivalent to approximately three passengers to meet the gross vehicle weight specified by the manufacturer. It is powered by 16 6-V lead/acid batteries (manufactured by Exide (ESB)) rated at 156 Ah. The batteries are configured as two modules: one under the hood of the vehicle and the other behind the rear seat (Figure 3 and 4). The SCR-operated controller is manufactured by HB Electrical Company and is located beneath the hood of the vehicle (Figure 5).

The propulsion motor is a 23-hp, series-wound motor (manufactured by General Electric). The Leopard has the standard Fiat suspension system with coil front springs, leaf rear springs, hydraulic double-action shocks, 5-speed manual transmission, power-assisted disc brakes in the front, and drum brakes in the rear. The tires are steel-belted radials (manufactured by Michelin) inflated to 248 kPa (36 lb/in.²). It comes equipped with an on-board charger (manufactured by U.S. Electricar Corporation) rated at 110 V a.c. with a peak current of 22 A (Figure 6).

The Lectric Leopard comes equipped with standard equipment such as windshield wipers, heater/defroster, fuel gauge, speedometer, and odometer and is also equipped with an ammeter and color-coded voltmeter which acts as a state-of-charge meter (Figure 7). The heater is a resistance-type (made by U.S. Electricar Corp) and is rated at 5000 Btu/h (Appendix C).

V. TEST RESULTS

The following are the results of verification tests performed at MERADCOM during 3 August 1981 to 25 September 1981 (paragraphs are reference to the DOE "Performance Standards for Demonstrations" criteria (Appendix A)):

475.10 (a) Acceleration: 0-50 km/h (31.1 mi/h) in 9.9 s.

(b) Gradeability at Speed: At 25 km/h (15.5 mi/h) the vehicle can traverse a 15.5-percent grade based on calculations from acceleration tests.

(c) Gradeability Limit: Calculations based on drawbar-pull tests indicate a 35.2-percent forward and a 36.4-percent reverse gradeability for at least 20 s.



Figure 1. Front of the Llectric Leopard.



Figure 2. Rear of the Lectric Leopard.

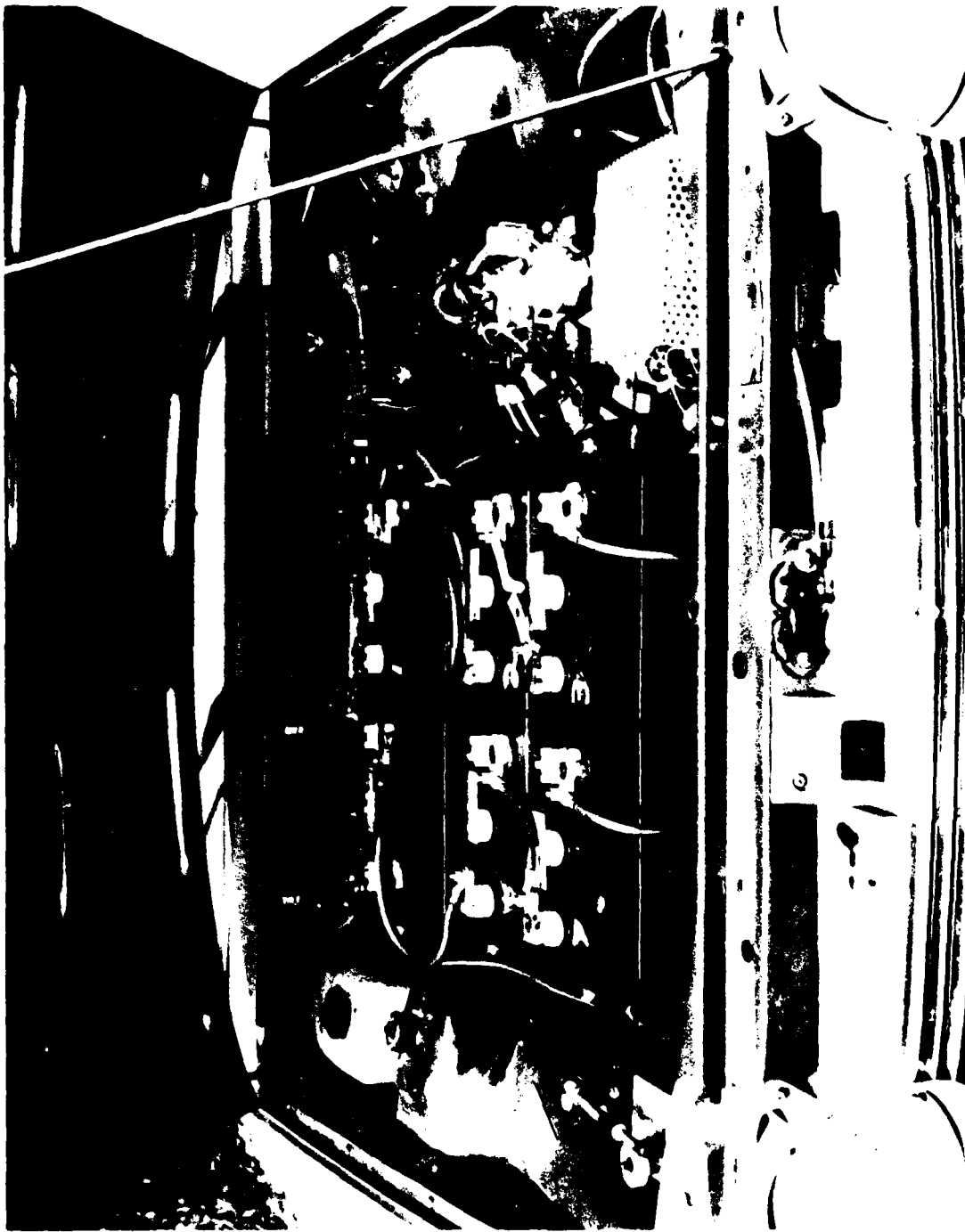


Figure 3. Front battery module.

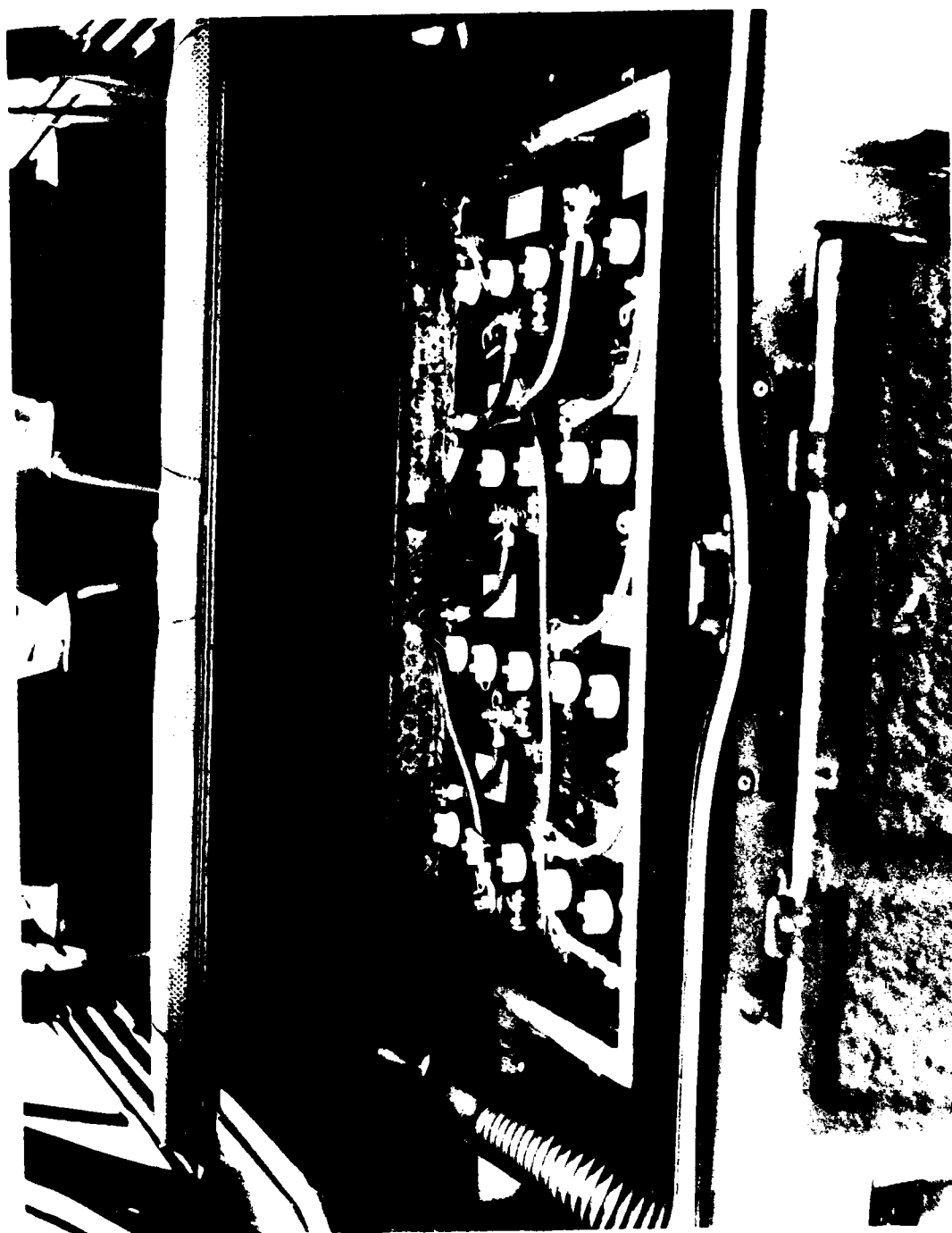


Figure 4. Rear battery module.

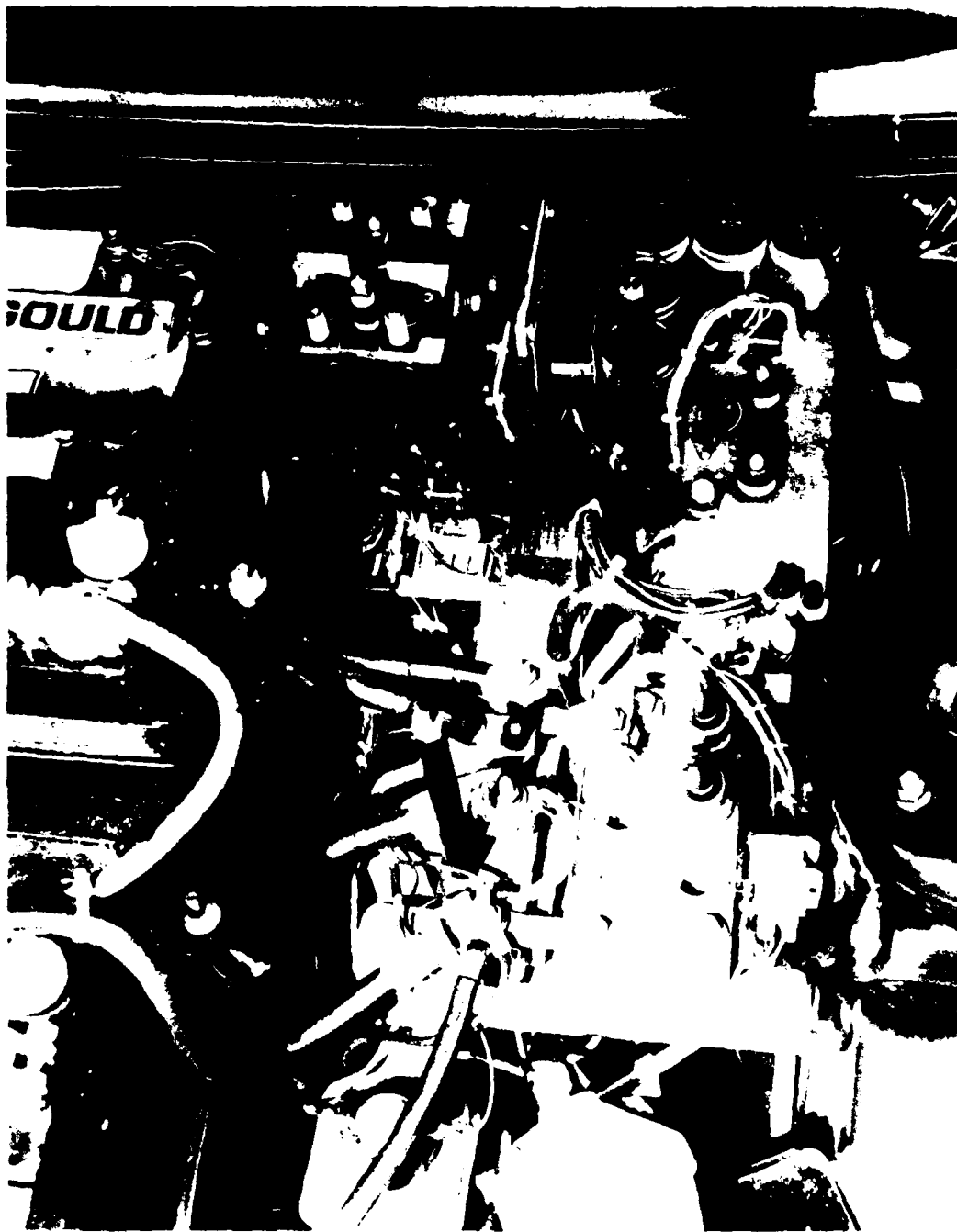


Figure 5. Silicon-controlled Rectifier (SCR) Controller.

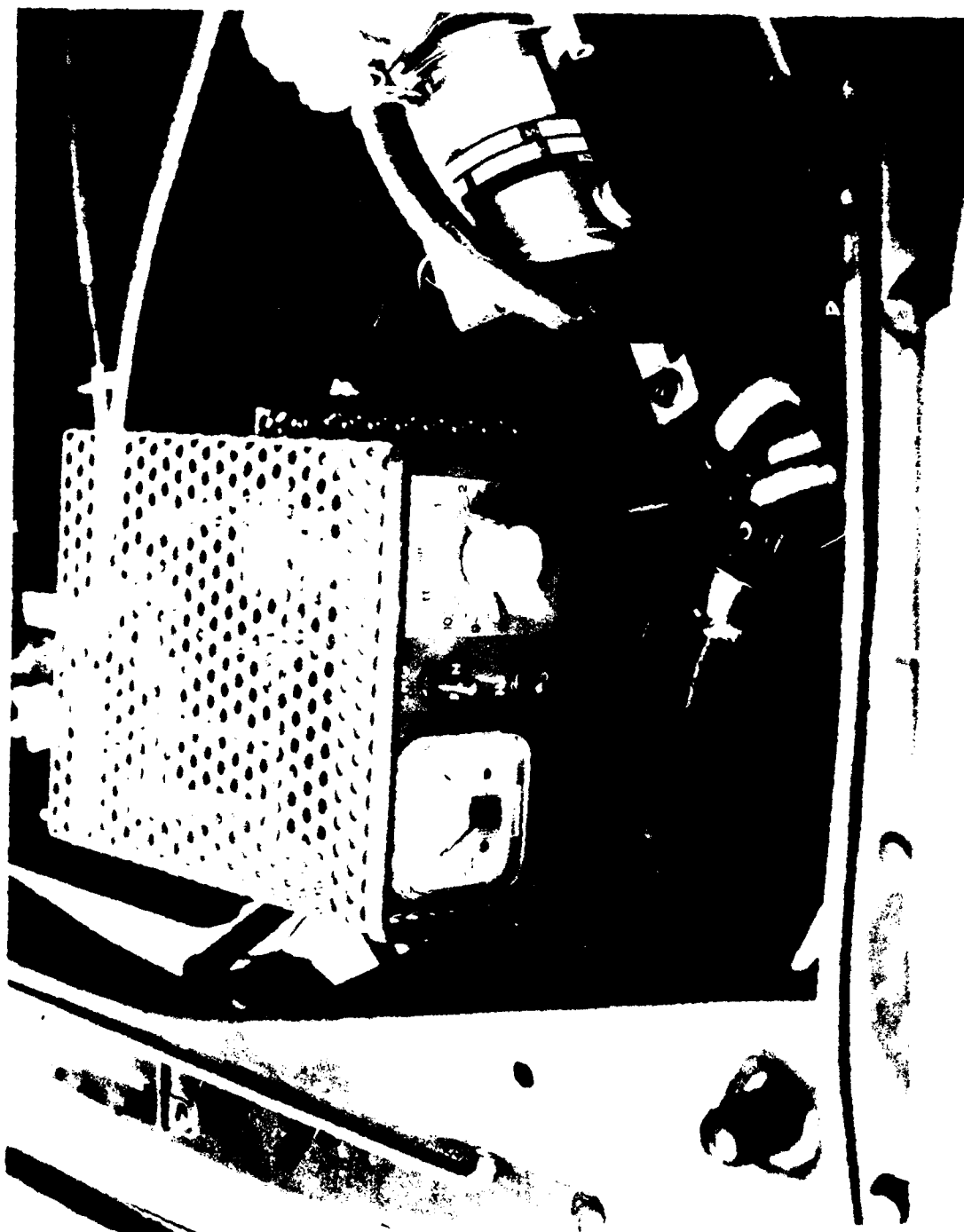


Figure 6. Battery charger.

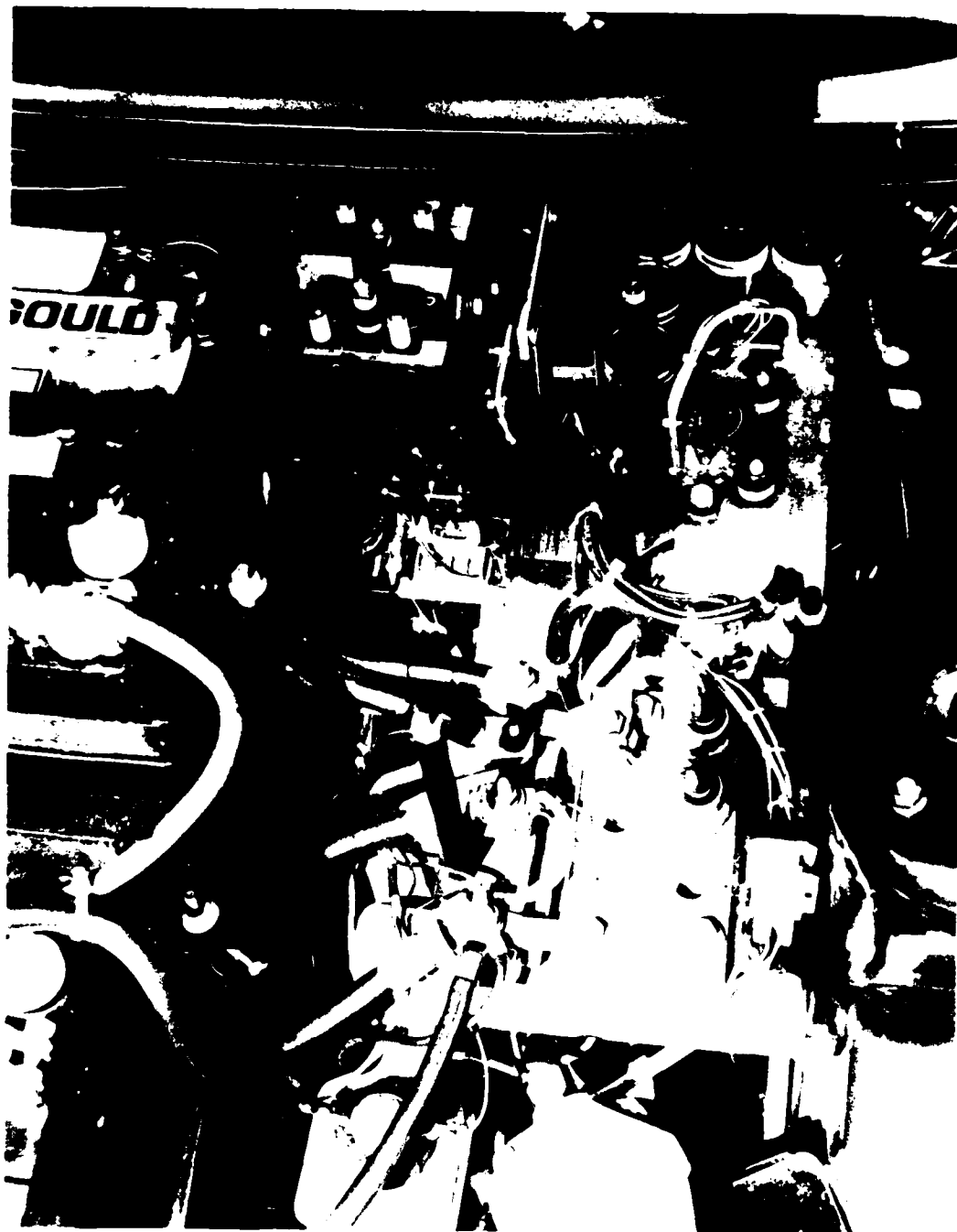


Figure 5. Silicon-controlled Rectifier (SCR) Controller.



Figure 7. Instrument panel.

(d) Forward Speed Capability: Forward speed of 80 km/h (50 mi/h) was maintained for more than 5 min on the level (\pm 1-percent grade) portion of the MERADCOM test track.

(e) Range: SAEJ227a Cycle "C" on level (\pm 1-percent grade) terrain yielded 66.2 km (41.2 mi) and 120 cycles.

(f) Battery Recharge Time: After an 80-percent depth of discharge (DOD), recharged with on-board charger (110 V, 20 A for 10 h. After recharge, the vehicle exceeded the minimum range requirement of 55 km (34.2 mi) to an SAEJ227a cycle "C" regime.

(g) Recharge Control: Tapered-current, manually preset up to 12 h, timer-terminated.

(h) Energy Consumption: The vehicle uses only electrical energy.

(i) Battery:

(1) Warranty: Unconditional 180 days, pro-rated remainder of year by battery manufacturer (1-yr umbrella warranty by vehicle manufacturer).

(2) Type: Lead-Acid, Exide XPV-23-3 (see Section VI).

(3) Capacity: 156 Ah (125 min at 75 A).

(4) Voltage: 96 V (16 6-V modules connected in series).

(j) State-of-Charge Meter: The vehicle is equipped with a color-coded voltmeter acting as a state-of-charge meter.

(k) Odometer: The vehicle is equipped with an odometer.

(l) Passenger Comfort Heater: Electric (manufactured by U.S. Electricar), rated at 1500 W (5000 Btu/h).

(m) Documentation: Operations Manual and Electrical Schematics were submitted with vehicle, but Maintenance Manual or Parts List were not.

(n) Emissions: Did not evaluate.

(o) Safety, etc.: The Department of Transportation is performing these evaluations. However, MERADCOM performed the following checks for design intent:

(1) Electrical Isolation: The electrical propulsion system is totally isolated from the vehicle chassis.

(2) Safety Standards 208 and 301: DOT will check compliance.

(3) Battery Caps: Standard golf-cart industry type. Flame barrier characteristics were not checked.

(4) Ventilation of Battery Compartment: The rear battery compartment is vented by a 60-ft³/min fan which operates while the vehicle is being charged and also when it is running. The fan is of sufficient capacity to change the air in the compartment 62 times per minute. The front compartment is not vented; however, it is opened to the air passing through the grill while the vehicle is running.

(5) Battery Emergency Disconnect: The vehicle is equipped with a manual transmission and the propulsion motor can be disconnected from the mechanical drive system by depressing the clutch.

(6) Parked Temperature Effect: Parked vehicle for 8 h at each of the temperatures -25° C and +50° C. Subsequent operation at those temperatures revealed no apparent damage to the vehicle or hazard to personnel.

VI. CHRONOLOGY OF VEHICLE FAILURES/CORRECTIVE ACTIONS

During initial testing of the Leopard, the vehicle appeared to be marginal in meeting test requirements. This was discussed with U.S. Electricar personnel and it was felt that the original batteries (SGL's model 2HGC-HC) in the vehicle did not have the capacity to meet the test criteria. The batteries were then replaced with Gould batteries by U.S. Electricar.

During accelerational test, a strong odor and smoke appeared from beneath the dashboard of the vehicle. The source was found to be the emergency disconnect switch which was not rated high enough for the application. The switch was bypassed by the U.S. Electricar personnel.

The vehicle would not meet minimum performance requirements with the Gould batteries. This was again discussed with U.S. Electricar Corp, and the vehicle was returned to them.

In July the test vehicle was returned to MERADCOM with new ESB XPV-23-3 batteries and tested to Verification requirements. This battery was the final one chosen by the manufacturer and was used for all test results in this report.

APPENDIX A

PERFORMANCE STANDARDS FOR DEMONSTRATIONS

FEDERAL REGISTER 12 FEBRUARY 1980 PART IV, SUBPART B

475.10 Minimum levels of performance for personal-use vehicles.

The following minimum levels of performance are required with respect to any personal-use vehicle purchased or leased in fulfillment of contracts entered into following the effective date of these regulations, pursuant to section 7 (c) of the Act.

a. Acceleration. The time required to accelerate from rest to 50 km/h shall not exceed 13.5 s for vehicles with a payload carrying capability of less than or equal to 600 kg.

b. Gradeability at speed. The grade which can be traversed up at 25 km/h shall be at least 10 percent.

c. Gradeability limit. The grade on which the vehicle can start and climb for 20 s each backward or forward shall be no less than 20 percent.

d. Forward speed capability. The speed which can be maintained for 5 min shall be 80 km/h.

e. Range. The distance which the vehicle can be operated with vital accessories on or equivalent, shall be:

(1) For an electric vehicle, at least 55 km on the SAE J227a/C cycle, and

(2) For a hybrid vehicle, at least 200 km on the SAE J227a/C cycle.

f. Battery recharge time. The vehicle shall be capable of satisfying the range requirement of section 475.10(e), above, after being recharged for no more than 10 h by use of an on-board charger. At the start of this recharge the vehicle shall have 80-percent discharged batteries as specified by the vehicle test conditions and procedures of section 475.3. The on-board charger shall be compatible with an electric power outlet of 110 V or 220 V a.c. as specified by the vehicle manufacturer.

g. Recharge control. The vehicle shall have an automatic recharge control which shall meet the requirements of energy, life, and safety as such requirements are stated by these performance standards. This paragraph applies when on-board chargers are used and also when off-board chargers supplied by or specified by the vehicle manufacturer for recharge of the vehicle are used.

h. Energy consumption:

(1) For an electric vehicle, the maximum amount of nonelectrical energy consumed shall be that used for operation of the accessories only.

(2) For a hybrid vehicle, nonelectrical energy consumed shall not exceed 1.3 MJ/km and shall also not exceed 75 percent of total energy consumed for propulsion and vital accessories, based on being fully loaded on a driving schedule of 33 km at 75 km/h (higher heating value of gasoline taken as 32.7 MJ/l) and with vital accessories on.

i. Battery life:

(1) The vehicle shall be capable of at least 75 percent of the range specified in 457.10(e) after 12 mo or 15,000 km of normal use, whichever occurs first.

(2) The vehicle shall be capable of 100 percent of the acceleration and gradeability specified in 475.10(a), (b), and (c), for all test conditions and procedures specified by 475.3 for 12 mo or 15,000 km of normal use, whichever occurs first.

(3) The batteries shall, if necessary, be repaired or replaced by the vehicle manufacturer at no cost to the user of the vehicle in order to meet requirements of (1) and (2) of 475.10(i).

j. State-of-charge meter. The vehicle shall have a state-of-charge meter for the propulsion battery system or other means of providing an indication of remaining range.

k. Odometer. The vehicle shall have an odometer.

l. Passenger comfort heater. The vehicle shall have the capability of having a passenger comfort heater installed at the option of the purchaser.

m. Documentation. Adequate user manuals, maintenance (service) manuals and parts lists shall be provided.

n. Emissions. The vehicle shall comply with all applicable Federal emissions regulations for motor vehicles.

o. Safety, crashworthiness, damageability, crash avoidance, and hazards:

(1) The vehicle shall comply with all applicable Federal motor vehicle safety standards as set forth in 49 CFR Part 571, unless a temporary exemption is obtained by the manufacturer from the Department of Transportation.

(2) Until the Department of Transportation issues regulations which cover the same subjects, the vehicle shall also have the following performance characteristics:

(i) The electric propulsion circuit shall be electrically isolated from other conductive portions of the vehicle sufficiently to prevent personal hazards due to contacting any portion of the electric propulsion circuit while in contact with other portions of the vehicle.

(ii) The vehicle shall be capable of complying with the performance requirements of Federal motor vehicle safety standards 208 and 301 with all battery materials remaining outside the passenger compartment.

(iii) Vehicles with battery vents shall have flame barrier provisions to inhibit battery explosions.

(iv) Ventilation shall be adequate within the battery compartment to maintain the concentration of hydrogen below 4 percent by volume during vehicle operation (including charging and maintenance).

(v) The vehicle shall have a device which provides for the positive disconnection of the battery and which is operable from the normal operator position.

(vi) The vehicle shall be capable of being parked for up to 8 h in temperatures of -25°C and $+50^{\circ}\text{C}$ and subsequently operated by moving forward under its own power at any temperature within this temperature range without damage to the vehicle or hazard to persons.

APPENDIX B

ELECTRIC AND HYBRID VEHICLE VERIFICATION PROCEDURES

BACKGROUND

DOE is required by Public Law 94-413 to issue performance standards for vehicles used in the Electric and Hybrid Vehicle (EHV) Market Demonstration. On 30 May 1978, DOE published a final rule in the Federal Register (Vol. 43, No. 104) promulgating the first Performance Standards. This rule was effective on 3 July 1978 and prescribed minimum performance standards for electric and hybrid vehicles to be purchased or leased for the first phase of a demonstration program under the Electric and Hybrid Research and Development Act of 1976. Performance Standards are updated from time to time and the current rule was published in the Federal Register on 12 February 1980 (Vol. 45, No. 30).

Manufacturers who certify that their vehicles meet the latest requirements of the DOE Performance Standards may offer those vehicles for the DOE Market Demonstration Program. DOE reserves the right to verify, by independent test, the manufacturer's self-certification. The test procedures used for DOE performance tests are based on SAE Test Procedures J227a. Safety inspection and testing services are provided by the Department of Transportation/National Highway and Traffic Safety Administration (DOT/NHTSA) through an interagency agreement. Performance testing is performed by the U.S. Army Mobility Equipment Research and Development Command through an interagency agreement. During verification testing, vehicle component or subsystem failures will be immediately brought to the attention of the manufacturer. Repeated or multiple component or subsystem failures experienced during test are grounds for invalidating the self-certification of the vehicle for purpose of the DOE Market Demonstration Program.

CERTIFICATION PROCESS

A manufacturer can certify an existing vehicle as meeting the DOE Standards (which include applicable NHTSA safety standards by reference) at any time by submitting a letter of certification and providing the required data on the vehicle to the Department of Energy Director of Electric and Hybrid Vehicles Division or his designee.

VERIFICATION PROCESS

Should DOE elect to verify the certification, arrangements will be made with the manufacturer for delivery of the vehicle to a DOE-specified site for testing. (Details of scheduling priorities are described in the following section.) Several basic types of tests may be involved:

- DOE-Sponsored Performance Tests by the U.S. Army MERADCOM.
- DOE-Sponsored Safety Inspection by DOT/NHTSA.
- DOE-Sponsored Safety Compliance Testing by the Research Division of DOT/NHTSA.
- DOT/NHTSA Safety Compliance Test (independent of DOE).

One important principle followed by DOE during testing is to allow the Facility Manager to work with manufacturers to overcome the normal problems that occur during inspection and testing. To ensure impartial treatment of manufacturers during the test sequence, limits have been set for the Test Facility Manager concerning how many vehicle component or subsystem failures can be allowed before certification is invalidated. DOE will objectively evaluate the impact of all failures during the testing phase so that vehicles are not unfairly penalized for minor and easily correctable failures. The Test Facility Manager, however, has an obligation to conduct the testing thoroughly and to adhere to a tight schedule.

Manufacturers may be notified from time to time by the Test Facility Manager of potential and actual problems. When these problems do not involve components or subsystem failures, where failure is defined as a vehicle being below the required standard, such notification would not necessarily invalidate the certification.

TEST FACILITY SCHEDULING GUIDELINES

Vehicles will be scheduled for testing by the Test Facility Manager on a first-come, first-served basis, with certain exceptions as noted below. Scheduling is dependent upon the ability of the manufacturer to provide a vehicle for testing. The Test Facility Manager will request the manufacturer to provide a certified vehicle for testing within 60 days from the date of the request. If a vehicle is not received at the Test Facility within the 60-day period, the self-certification will be returned and the vehicle will be removed from the self-certification list.

The primary function of certification testing is to ensure that vehicles available to the Market Demonstration Program fully satisfy the applicable DOE Performance Standards. For this reason it is necessary to establish a set of priority testing categories for vehicles selected or being considered for selection by demonstration site operators. The categories are listed below in decreasing order of priority for testing:

1. Certified vehicles which have not been verified but have been purchased by and delivered to site operators.
2. Certified vehicles purchased by but not delivered to site operators for demonstration.
3. Certified vehicles that have been modified subsequent to verification testing and have been delivered to site operators.* On request by DOE, the manufacturer will furnish DOE with technical information about each modification in sufficient detail to determine if reverification tests are needed.
4. Certified vehicles that are being considered for purchase by a site operator.
5. Certified vehicles that are available for test but are not under consideration by a site operator.

Vehicle test schedules are sensitive to the requirements of the Market Demonstration Program, and rescheduling by the Test Facility Manager may be required to meet changing needs. Vehicles delivered late or taken out of test because of operational failure may be rescheduled on a lower priority basis by the Test Facility Manager with approval of the DOE Test Manager. On-site rectification of a vehicle problem by the manufacturer within a 5-working-day period described below may avoid the necessity for rescheduling.

VEHICLE MODIFICATION/REPAIR GUIDELINES

The guidelines provided in this section are for use by the Test Facility Manager. Exceptions to these guidelines require the approval of the Director of the DOE Electric and Hybrid Vehicle Division or his designee. The intent of these guidelines is to facilitate the establishment of a clear basis for validating or invalidating a manufacturer self-certification. Subsystem failures may raise questions as to the relevance of the results of the validation testing. It is also important that the test facilities not be used for development and test engineering. Vehicles that experience repeated failures of the same components or subsystems must be upgraded before verification testing can be rescheduled. Rescheduling will

* The manufacturer is responsible for notifying the DOE Director of the Electric and Hybrid Vehicle Division or his designee of all modifications to the verified production configuration.

be contingent on the submission and acceptance of evidence, obtained by the manufacturer through testing, that the cause of failure has been corrected. The Test Facility Manager will determine when significant repairs should be and have been made.

VEHICLE MODIFICATIONS/REPAIRS ON OR NEAR THE TEST FACILITY

A. Only those modifications or repairs that can be completed within 5 working days by the manufacturer or his designee will be allowed. If the repairs cannot be completed within this period, the vehicle must be removed from the test facility unless DOE programmatic requirements dictate that it is in the best interest of the Government that a waiver be granted by the Director of the Electric and Hybrid Vehicles Division or his designee.

B. All failures requiring repair, whether significant or insignificant, will be recorded by the Test Facility Manager or his designee. For all repairs, the manufacturer must submit (to the Test Facility Manager) written explanation of the failure modes and the corrective action taken within 15 days after completion of corrective action. Failed components or subsystems must be replaced by an identical part except in those cases where the component or subsystem design is inadequate. In the latter case, the manufacturer may substitute a readily available component or system when the manufacturer can provide assurance of improved reliability and performance.

C. Three on-site repairs to correct a significant powertrain failure are allowed. A fourth failure will invalidate the vehicle certification, and the Facility Manager will order the vehicle to be returned to the manufacturer unless DOE programmatic requirements dictate that a waiver be granted by the Director of the Electric and Hybrid Vehicles Division or his designee.

D. Subject to overriding priority considerations, testing will be resumed as soon as repairs are completed.

VEHICLES RETURNED TO THE MANUFACTURER BECAUSE OF FAILURE IN TEST

A. A letter invalidating the certification will be issued to the manufacturer and DOE will notify site operators of the invalidation. A report including the vehicle failures will be provided by DOE to members of the public requesting such a report. Vehicles that are part of the Market Demonstration Program (based on the manufacturer's self-certification) which fail the verifications tests will have their certifications invalidated until successful correction of the defects is completed. Future funding to site operators for the invalidated vehicle model will be suspended until corrections are completed.

B. A one-time voluntary withdrawal of a vehicle from test by a manufacturer to correct problems is allowed for a period not to exceed 60 days. The vehicle will be re-scheduled for testing based on priorities at the time of resubmittal. No action will be taken to invalidate the certification during the voluntary withdrawal period unless there is a clear case of user safety involved or the manufacturer fails to offer the vehicle for test after 60 days.

C. Before a vehicle can be resubmitted for testing, the manufacturer must provide to the Director of the Electric and Hybrid Vehicles Division, or his designee, appropriate evidence that modifications and/or repairs have been made. The manufacturer must also provide substantiating test data to show that the vehicle can meet all DOE Performance Standards.

D. Repaired vehicles returned by the manufacturer may be required to undergo the complete series of verification tests regardless of the portion of testing completed prior to invalidation of certification. The Test Facility Manager with the approval of DOE will determine the necessity for such retesting.

GROUND FOR INVALIDATING CERTIFICATION

1. A vehicle will be returned to the manufacturer after four significant powertrain failures or a single powertrain failure that cannot be corrected, and its certification will be invalidated.

2. A vehicle that fails to meet applicable DOE Performance Standards will have its certification invalidated. (The standards include documentation and warranty provisions.)

3. A vehicle that fails to comply with applicable DOT/NHTSA Safety Regulations will have its certification invalidated.

4. If a manufacturer fails to commit to and follow a reasonable schedule (defined in the following section) to provide a vehicle for testing when requested by DOE, the vehicle will have its certification invalidated.

SUMMARY OF RESPONSIBILITY OF MANUFACTURERS

Manufacturers must self-certify their production vehicles to participate in the DOE Market Demonstration Program. They must also commit to a reasonable schedule to provide a vehicle for verification testing upon request from the DOE designated Test Facility Manager. If this delivery cannot be made within 60 days after receipt of such a request, the self-certification letter will be returned and the vehicle will be removed from the self-certified list.

Manufacturers must provide required and necessary information to document the vehicle configuration:

- Vehicle Summary Data Sheets,
- Operator's Manual, and
- Service and Maintenance Manual including a parts list.

This information may be in draft form, but it must be complete enough to be useful should any mechanical or electrical difficulty develop in the vehicle.

The manufacturer will notify the Director of the Electric and Hybrid Vehicles Division or his designee of all modifications to previously verified production configurations within 30 days of the sale of such modified vehicles to DOE site operators. If it is requested, the manufacturer shall furnish the DOE Test Manager with technical information about each modification in sufficient detail to determine if reverification tests are needed.

For vehicles receiving an invalidation of certification, the manufacturer must provide to the Director of the Electric and Hybrid Vehicles Division appropriate evidence that modifications and/or repairs have been made and must also provide substantiating test data to show that the vehicle can meet all DOE Performance Standards prior to resubmittal of the vehicle for test. Following successful verification testing, vehicles already in DOE site operator fleets must be modified and/or repaired in the same manner as the vehicle successfully tested. A modification and/or repair schedule acceptable to the Director of the Electric and Hybrid Vehicles Division must be developed and followed by the manufacturer as a condition for validation of the manufacturers certification.

DOE NOTIFICATION DOCUMENTATION

DOE will notify manufacturers of actions taken during the verification testing process, including but not limited to:

- Receipt of self-certification.
- Notification of vehicle failure.
- Validation or invalidation of certification.
- Final test report.

APPENDIX C

VEHICLE DATA SUMMARY SHEET

1. VEHICLE MANUFACTURER AND ADDRESS:

U.S. Electricar Corporation
250 South Main Street
Athol, Massachusetts 01331

2. VEHICLE DESCRIPTION:

Name: Lectric Leopard
Model: 964AD
Availability: 30 Days ARO
Price: \$13,895.00 (12/15/81)

3. VEHICLE WEIGHT:

Curb Wt: 1491.4 kg (3288 lb)
Passenger Wt: 1 adult 74.8 kg (165 lb)
Driver Wt: 74.8 kg (165 lb)
Payload Wt: 68 kg (150 lb)
Gross Wt: 1709.2 kg (3768 lb)

4. VEHICLE SIZE:

Wheelbase: 2.19 m (96.4 in.)
Length: 4.08 m (161 in.)
Width: 1.65 m (65 in.)
Headroom: 0.86 m (34 in.)
Legroom: 0.76 m (30 in.)

5. AUXILIARIES AND OPTIONS:

No. Lights: 18
Type and Functions: Exterior
a. Head and tail lamps/stop lamps
b. Front/rear sidemarkers

- c. Front/Rear Parking
- d. 2 Rear Backup
- e. 2 License Plate lamps

Windshield Wipers: Yes
Windshield Washers: Yes
Defroster: Yes
Heater: Yes
Radio: No
Fuel Gage: Yes
Ammeter: Yes
Tachometer: No
Speedometer: Yes
Odometer: Yes
No. Mirrors: 2
Power Steering: No
Power Brakes: Yes
Transmission Type: 5-Speed standard synchromes

- a. 1st gear ratio, 3.583:1
- b. 2nd gear ratio, 2.235:1
- c. 3rd gear ratio, 1.454:1
- d. 4th gear ratio, 1.042:1
- e. 5th gear ratio, 0.863:1
- f. Reverse gear ratio, 3.714:1

6. PROPULSION BATTERIES

Type: Lead Acid
Manufacturer: Exide XPV-23-3
No. of Modules: 16 (8 front/8 rear)
No. of Cells: 48
Battery Voltage: 96 V
Ah Capacity: 156
Module Size: 0.25 m x 24 m x 0.18 m
(10 in. x 9.5 in. x 7 in.)
Module Wt: 30 kg (66 lb)
Battery Rate: 125 min @ 75 A
Battery Cycles: 400 (battery manufacturer's rating)

7. AUXILIARY BATTERY

Type: Lead Acid
Manufacturer: Gould
No. Cells: 6
Ah Capacity: 60
Battery Voltage: 12 V
Battery Size: 0.15 m x 0.25 m x 0.18 m
(6 in. x 10 in. x 7 in.)
Battery Wt: 12 kg (28 lb)

8. CONTROLLER

Type: SCR
Manufacturer: HB Electrical
Voltage Rating: 96 V
Current Rating: 800 A
Size: 0.3 m x 0.2 m x 0.14 m
(19.3 in. x 7.8 in. x 5.7 in.)
Weight: 21.3 kg (47 lb)

9. PROPULSION MOTOR

Type: Series
Manufacturer: GE
Insulation Class: "H"
Voltage Rating: 96 V
Current Rating: 201 A
HP Rating: 23
Weight: 77 kg (170 lb)
Size: 0.23 m dia. x 0.44 m long
(9 in. dia x 17.5 in. long)
Rated Speed: 2300 r/min
Max Speed: 7500 r/min

10. BODY

Type: Sedan
Manufacturer: Fiat (Strada)
No. Doors: 5
Type: 4 side, 1 rear hatch
No. Windows: 10
Type: Laminated, Tinted Glass
No. Seats: 3
Type: 2 bucket, 1 bench
Cargo Volume: .14 m³ (4.9 ft³)

11. CHASSIS

Type Frame: Utilized
Manufacturer: Fiat
Type Material: Steel
Modifications: Leaf added to rear springs
Type Sprongs: Coil, Front/Leaf, Rear
Type Shocks: Hydraulic, Telescopic, Double-Action
Axle Type Front: Half Shaft
Rear: Half Shaft
Axle Manufacturer: Fiat
Drive Line Ratio: 3.588:1
Type Brakes: Disc, Front/Drum, Rear
Regenerative Brakes: No
Tire Type: Radial
Manufacturer: Michelin
Size: 145SR x 13
Pressure: 248 kPa (35 lb/in²)
Rolling Radius: 0.27 m (10.5 in.)

12. BATTERY CHARGER

Type: Tapered Current, Silicone Diode Controlled Full Wave Rectifier
Manufacturer: U.S. Electricar Corp.
On or Off Board: On Board
Input Voltage: 120 Va.c.
Peak Current: 22 A
Recharge Timer: Spring/Mechanical
Size: 0.18 m x 0.2 m x 0.3 m
(7 in. x 8 in. x 12 in.)
Automatic Turn Off: Timer Controlled

Weight: 27.2 kg (60 lb)

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